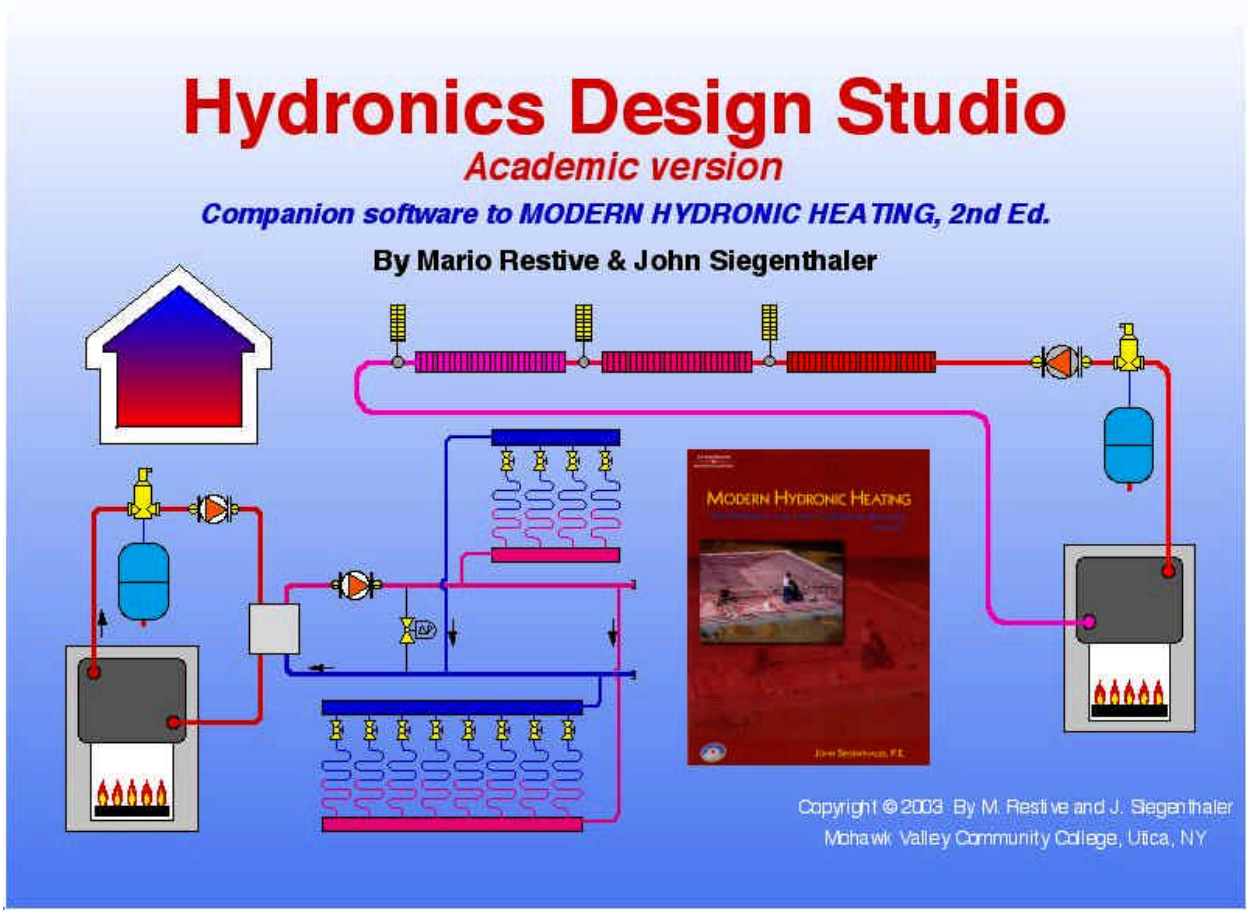
USER MANUAL


Hydronics Design Studio
Academic version
Companion software to MODERN HYDRONIC HEATING, 2nd Ed.
By Mario Restive & John Siegenthaler
MODERN HYDRONIC HEATING
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Mohawk Valley Community College, Utica, NY

The Hydronics Design Studio Academic Version (Academic Version)

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Table of Contents:

System Requirements:

The **Hydronics Design Studio Academic Version (Academic Version)** requires Microsoft Windows®95, 98, 2000, or XP operating system. Your system should also have a minimum of 128 Mbytes of RAM memory, and at least 25 Mbytes of available hard disk space for program installation. The system also requires a CD-ROM drive for software installation.

Installing the Program:

Simply put the CD-ROM into your systems CD drive, and close the tray. The software automatically starts an installation routine, prompting you for any necessary information

Running the Program:

After the program is installed, you can access it by first clicking the “START” button on the Windows desktop. Move the mouse cursor upward until the word “Programs” is highlighted. Another window will open listing the programs installed on your computer. If the words **Hydronics Design Studio Academic Version** appears in this window move the mouse cursor down to highlight it. If these words do not appear, move the mouse cursor to the bottom or top center of the list. The list should scroll downward or upward until the words **Hydronics Design Studio Academic Version** appear. Next, move the mouse button down to highlight the words. A small window will open to the right showing the program file icon and the name **Hydronics Design Studio Academic Version** . Click on the icon to launch the software. After a short time the start-up screen should appear.

You may want to create a screen shortcut to the Hydronics Design Studio Academic Version . Follow the instructions for the version of Windows you are using to create the screen shortcut.

NOTE: The program is optimized for viewing at 800 x 600 screen resolution. For a full screen display, you should set your monitor to this resolution using the setting tab in the display controls panel.

INTRODUCTION

Welcome to the Hydronics Design Studio - Academic Version . This software package contains five modules that assist with the numerical calculations needed to analyze and design residential and light commercial hydronic systems.

The five program modules included are as follows:

- ROOM HEAT LOAD ESTIMATOR
- SERIES BASEBOARD SIMULATOR
- HYDRONIC CIRCUIT SIMULATOR
- EXPANSION TANK SIZER
- FLUID PROPERTIES CALCULATOR

Each module is accessed by left-clicking the mouse arrow on the associated icon at the top left corner of the screen. All modules load when the program is launched and run simultaneously. The user can switch from one to another at any time by clicking on the icons.

The following is a brief description of each module:

ROOM HEAT LOAD ESTIMATOR

This module estimates the design heating load of a building on a room-by-room basis. Within a given room, the heat loss associated with each exposed surface as well as that due to air leakage is instantly calculated and displayed. A bar graph shows the proportion of the total heat loss associated with each loss path making it easy to see where the majority of the heat losses are occurring. A unique area and volume calculator lets you quickly determine the correct areas and room volumes associated with heat loss estimates. A listing of rooms with their associated heat losses can be quickly generated. The total heating load of the building is automatically tabulated and displayed as rooms are added, erased, or modified.

SERIES BASEBOARD SIMULATOR

This program module determines the performance of series-connected fin-tube baseboard circuits. As hardware is selected and loads are assigned, a detailed engineering simulation of the circuit is performed. In addition to sizing each of the baseboards, this simulation determines the flow rate produced by the selected circulator, as well as the inlet and outlet temperatures of each baseboard. Hardware and operating conditions can be quickly changed to evaluate design alternatives. The module also warns the user of inappropriate selections or operating conditions. Up to four series-connected baseboards can be assigned to a piping circuit. One or two "zone" circuits can be created. The type of baseboard used in any room can be selected from a large database, as can the circulator and system fluid. Each circuit can be configured using one of several types and sizes of tubing as well as a wide assortment of fittings and valves.

HYDRONIC CIRCUIT SIMULATOR

This module simulates the steady-state fluid flow and heat output in a variety of piping systems commonly used for hydronic heating. It is capable of modeling the flow rates in series-piped and parallel-piped closed-loop systems constructed of smooth tubing such as copper, PEX, or PEX-AL-PEX.

The graphic user interface (GUI) allows the user to quickly configure the piping system to be simulated. The software contains databases for piping, fittings, valves, circulators, and fluids that are accessed through standard pull downs and scrollable lists. The interface is simple and easy to learn, yet allows total access to powerful mathematical simulation models.

EXPANSION TANK SIZER

This module determines the minimum volume of a diaphragm-type expansion tank required for a user-specified closed-loop hydronic heating system. It also calculates useful information such as the volume of antifreeze that may be required, as well as the volume of various types and sizes of tubing.

FLUID PROPERTIES CALCULATOR

This module calculates several properties for fluids commonly used in hydronic heating systems including density, viscosity, specific heat, and the "alpha-value" which is used to

determine hydraulic resistance. These properties are required by many of the formulas presented in the text *Modern Hydronic Heating.*

GENERAL PROGRAM INFORMATION

DEFAULT VALUES:

Each input in every module has an assigned default value or selection when the program launches. These values / selections ensure the program will not stop due to lack of information. The user can always override the default values. However, the original default values will appear each time the program is restarted.

RANGE CHECKING:

The program checks the validity of all information entered. If an entered value is either out of range, or of an inappropriate type for the input, the program will not accept the input. Instead it will either show the closest permissible value for that input, or return to the default setting. The ranges of most inputs are described in the help files associated with each module.

USER INSTRUCTIONS / HELP SYSTEM:

A complete user instruction / help system is built into each module, and can be access by pressing the "?" button at the top of each screen. After reading the information, press the "Close" button to return to the module screen.

PRINTING INFORMATION:

Each of the five modules has a print screen button at the top of the screen. Pressing this button will send an exact copy of the current screen to the printer. Be sure the printer is turned on before pressing this button.

SAVING INFORMATION:

The academic version of the Hydronics Design Studio does not have file storage capabilities. All inputs will be reset to default values whenever the program is rebooted.

WARNING MESSAGES:

Some modules check for operating conditions that are generally not recommended for the type of system being simulated. An example would be a flow velocity in excess of 4 feet per second. When such conditions are detected, the program will display a warning message. This message will remain displayed until the user changes the input so that the simulated system is operating within acceptable conditions.

EXITING THE PROGRAM:

To exit the program, use the EXIT pull down at the top of the screen, or press the close window button [X] at the top right corner of the screen.

WEBSITE LINK:

If the system on which the Hydronics Design Studio Academic Version is running has an active link to the Internet, the user can visit the developers site at www.hydronicpros.com through the pulldown menu item at the top of the screen.

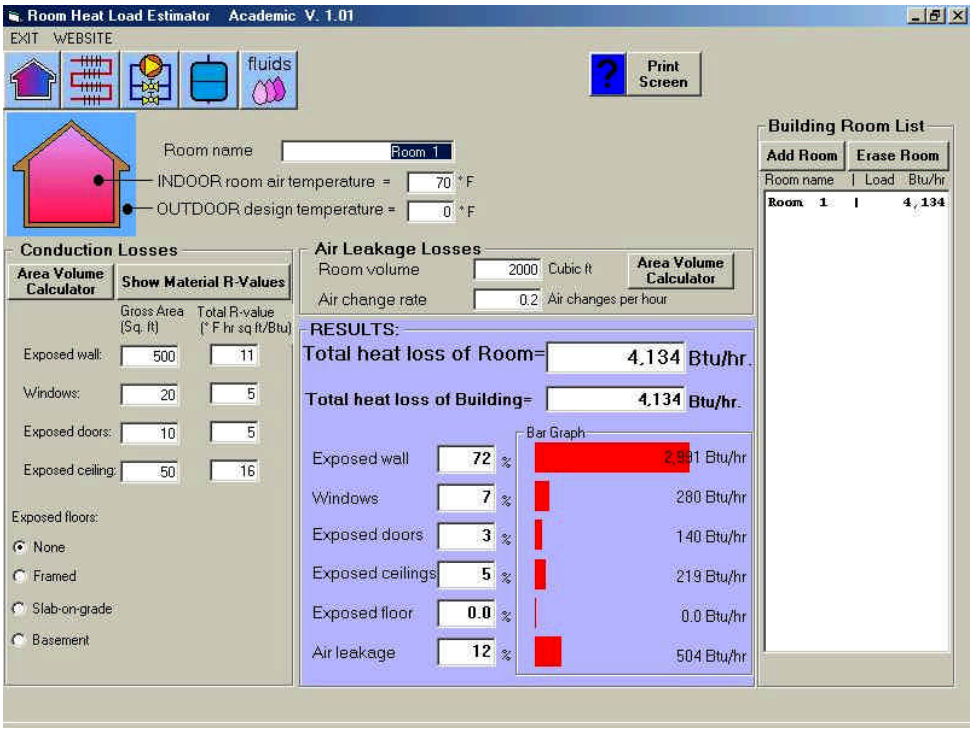
ROOM HEAT LOAD ESTIMATOR

GENERAL:

The ROOM HEAT LOAD ESTIMATOR module estimates the design heating load of a building on a room-by-room basis. Within a given room, the heat loss associated with each exposed surface as well as that due to air leakage is instantly calculated and displayed. A bar graph shows the proportion of the total heat loss associated with each loss path making it easy to see where the majority of the heat losses are occurring.

A unique area and volume calculator lets you quickly determine the correct areas and room volumes associated with heat loss estimates.

A listing of up to three rooms with their associated heat losses can be quickly generated. The total heating load of the building is automatically tabulated and displayed as rooms are added, erased, or modified.



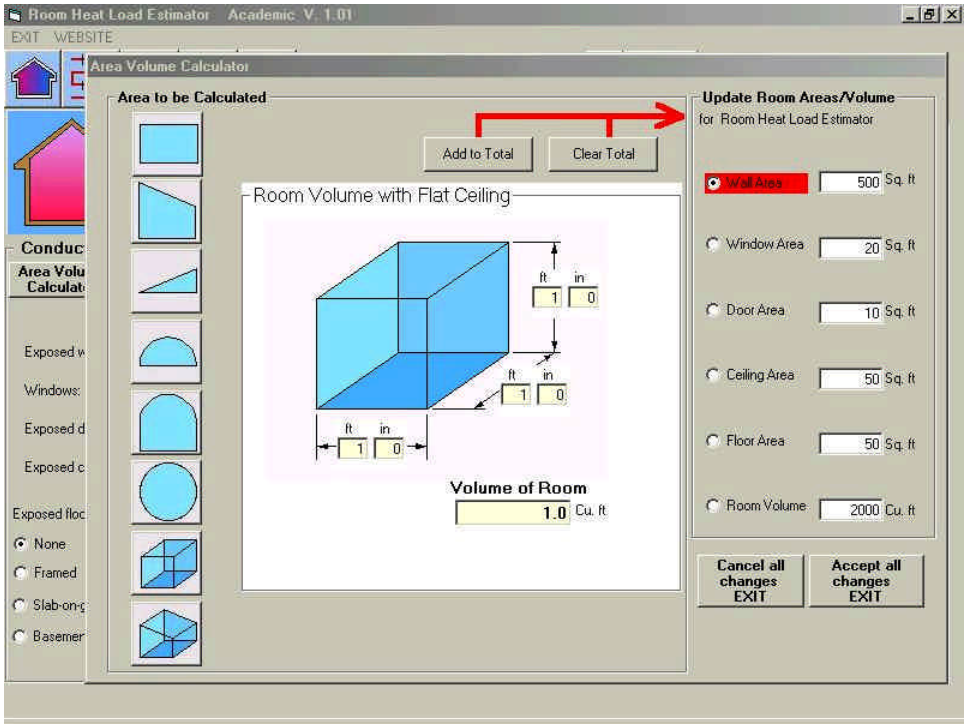
INPUTS:

ROOM NAME:
Enter text (up to 16 characters) for the room name.

INDOOR ROOM AIR TEMPERATURE:
Enter the desired indoor comfort air temperature to be maintained during design load conditions. The value entered must be between 45 and 90 ºF.

OUTDOOR DESIGN TEMPERATURE:
Enter the outside air temperature at design load conditions. The value entered must be between –60 and 45 ºF.

AREA / VOLUME CALCULATOR:
Clicking either of the Area Volume Calculator buttons on the main screen opens a new window over the main program screen as shown below.



The Area Volume Calculator can quickly determine the area of basic shapes such as rectangles, trapezoids, triangles and more. These shapes can represent walls, windows, doors, ceilings or floors. This tool can also calculate the volume of spaces with either flat or sloped ceilings

To use the Area volume calculator, click on the basic shape that represents the surface for which the area is to be determined. An enlarged view of that shape now appears in the dimensions window at the center of the screen, along with input fields for the necessary dimensions. The user can drag over an input field or click on a value to highlight it, then type in a new value. Only whole numbers can be entered for either feet or inches. When the return key is pressed, or the cursor is moved to a different field, the area is instantly updated.

The current areas for all exposed surfaces, and room volume are displayed at the right side of the screen. One of these areas (or the room volume) is highlighted in red. This is called the "active area." It is the area (or volume) that will be modified when either of the buttons at the top of the screen is clicked. Clicking the "Clear total" button zeros the current active area field. Clicking the "Add to Total" button adds the area currently displayed in the dimensions window to the active area total.

The user can calculate the area of a complex surface by breaking it up into simpler shapes, determining the area of the simple shapes one at a time, then click the "Add to Total" button.

Once all areas and the room volume are determined, click the "Accept all changes EXIT" button at the bottom right to return to the main room heat loss screen. All the currently displayed areas for exposed wall, windows, doors, floors, and ceilings, as well as the room volume will be inserted into the appropriate area and volume inputs for the currently selected room on the main screen. You can also exit the Area Volume Calculator without accepting any changes to the area by clicking the "Cancel all changes EXIT" button.

EXPOSED WALL:

This is the area of the wall that separates the heated spaced (e.g. the room) from unheated space. The number entered must be between the sum of the areas of the windows plus doors, and 50,000 square feet. If there are no exposed walls in the room set the entry to 0.

Do not subtract the area of any windows or doors in the exposed wall. The program will do this automatically.

Enter the total R-value of the exposed wall in the box to the right of the area field. The value entered must be between 0.1 and 100. If there is no exposed wall, leave the R-value entry set to its default value.

The total R-value of the wall is determined by combining the R-values of the various materials making up the wall, and possibly adjusting for the presence of framing materials.

A reference list of common building materials and their associated R-values is available as the "Show Material R-values" button. If desired, numbers may be copy and pasted from this list to the Total R-value inputs.

WINDOWS:

Enter the total area of any window(s) in the exposed wall. The area entered should be the "unit area" of the window including the frame and glazing. The value entered must be between zero and an upper limit equal to exposed wall area minus the exposed door area. If there are no windows, set the entry to zero. The program automatically subtracts the window area from the gross wall area when the calculations are performed.

Enter the unit R-value of the window the right of the area field. Only one type of window is allowed per room, (e.g. one window R-value). The value entered for the window R-value must be between 0.1 and 10. If there are no windows, leave the R-value entry set to its default value.

EXPOSED DOORS:

Enter the total area of any doors in the exposed wall. The value entered must be between zero and an upper limit equal to exposed wall area minus window area. If there are no exposed doors, set the entry to zero. The program automatically subtracts the exposed door area from the gross wall area when the calculations are performed.

Enter the unit R-value of the exposed door(s). Only one type of door is allowed per room (e.g. one door R-value). The value entered for the door R-value must be between 0.1 and 20. If there are no exposed doors, leave the R-value entry set to its default value.

EXPOSED CEILING:

An “exposed” ceiling is any type of ceiling through which heat leaves the room. If the space above the ceiling is maintained at the same temperature as the room, there is no heat flow through the ceiling, and thus the ceiling is not considered exposed. In this case, set the area of the exposed ceiling to 0.

EXPOSED FLOOR:

An “exposed” floor is any type of floor through which heat leaves the room. If the space below the floor is maintained at the same temperature as the room, there is no heat flow through the floor, and thus the floor is not considered exposed. In this case, leave the floor type set to the default value of “None.”

If there is heat loss through the floor, select the type of floor by pressing one of the buttons marked “Framed,” Slab-on-grade,” or “Basement.” The appropriate input fields for the type of floor selected will appear on the screen.

FRAMED FLOOR:

For a framed floor, enter the area of the floor in square feet. The value entered must be between 0 and 50,000.

Also enter the temperature of the air below the framed floor. This input automatically defaults to the outdoor design temperature entered at the top of the screen. However, it can be overwritten by entering another value between –60 ºF and 80ºF. NOTE: The value entered must be equal to or less than the indoor room air temperature. If it is higher, the program issues a warning, and changes the value back to the room air temperature.

Also enter the Total R-value of the floor assembly. The total R-value of the floor is determined by combining the R-values of the various materials making up the floor assembly, and possibly adjusting for the presence of framing materials.

A reference list of common building materials and their associated R-values is available as the “Show Material R-values” button. If desired, numbers may be copy and pasted from this list to the R-value input.

SLAB-ON-GRADE FLOOR:
For a slab-on-grade floor, enter the length of the exposed slab edge for the room. The value entered must be between zero and 50000 feet. Also enter the R-value of any insulation added to the edge of the slab.

BASEMENT FLOOR:
Enter the Area of the basement floor and the R-value of any underslab insulation.

ROOM VOLUME:
Enter the volume of the room in cubic feet. The value entered must be between 0 and 500,000 cubic feet. For rooms with flat ceilings, the room volume is determined by multiplying the floor area by the ceiling height. For rooms with sloping ceilings, the room volume is determined by multiplying the floor area by the average ceiling height. If you need to calculate the room volume, press the “Area Volume Calculator” button to open the associated screen (see previous description of how to use the Area Volume Calculator).

AIR CHANGE RATE:
Enter the estimated rate of air changes in the room. This value entered must be between 0 and 10. Typical air change values range from 0.3 (for very tight modern construction) to 2.5 for older buildings with poor insulation and air sealing quality.

BUILDING ROOM LIST
This area of the screen allows you to make a list of up to three rooms in a building (including the basement if desired). Clicking the “Add Room” button will add the name of the currently specified room to the list, as well as add the heat loss of that room to the building total. Any room can be deleted from the list by double clicking on the room name to select it, then clicking the “Erase Room” button.

Clicking on any room name in the Building Room List will change the inputs to those for that selected room. Thus room specifications can be easily changed and the building heat load updated based on those changes.

RESULTS:

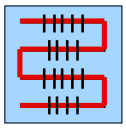
TOTAL HEAT LOSS OF CURRENTLY SPECIFIED ROOM:

The total heat loss of the currently specified room is displayed. This value is automatically recalculated when any of the inputs are changed. Note: For a changed input to take effect, the return key must be pressed, or the mouse cursor clicked on a different area of the screen.

TOTAL HEAT LOSS OF BUILDING:
The sum of the heat losses of all rooms in the Building Room List is displayed in this area.

BAR GRAPH:
The bar graph in the lower right corner of the screen displays the heat loss and percentage of the total heat loss associated with each of the exposed surfaces as well as air leakage. The bar graph automatically updates when any of the inputs are changed.

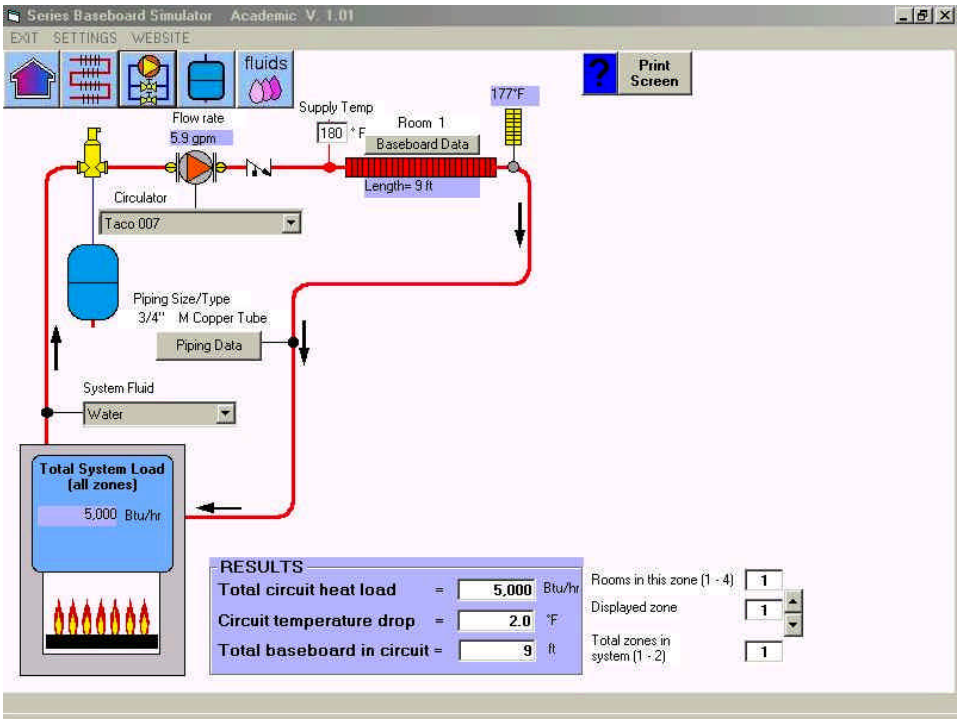
PRINT SCREEN:
Pressing the "Print screen" key at the top of the screen will send the current screen image to the printer. Be sure the printer is on before using this function.



SERIES BASEBOARD SIMULATOR

GENERAL:

The SERIES BASEBOARD SIMULATOR module determines the performance of series-connected fin-tube baseboard circuits. As hardware is selected and loads are assigned, a detailed engineering simulation of the circuit is performed. In addition to sizing each of the baseboards, this simulation determines the flow rate produced by the selected circulator, as well as the inlet and outlet temperatures of each baseboard. Hardware and operating conditions can be quickly changed to evaluate design alternatives. The program module also warns the user of inappropriate selections or operating conditions. Up to three series-connected baseboards can be assigned to a piping circuit. Up to ten independent zone circuits can be created. The type of baseboard used in any room can be selected from a large database, as can the circulator and system fluid. Each circuit can be configured using one of several types and sizes of tubing as well as a wide assortment of fittings and valves.



INPUTS:

TOTAL ZONES:
Click or drag the cursor to select the number in this box at the top of the screen. Enter a number from 1 to 4 to specify the number of independent zone circuits the system will have.

Each zone circuit can have up to four baseboards. Any baseboard make and model in the database can be assigned to a given baseboard location with a circuit. Each zone circuit can also have it own specific circulator, and piping components.

All zone circuits must operate with the same fluid (since they are all part of the same system). Each baseboard circuit must also have the same supply water temperature (since all circuits are assumed to be supplied form a common boiler).

DISPLAYED ZONE:
When there is more than one zone circuit in the system, change the number in the Displayed Zone field to view the current inputs and piping configuration for a given zone.

ROOMS IN THIS ZONE:
This input lets the user specify the number of series-connected baseboards in the currently displayed zone. The piping schematic will automatically adjust to show the number of baseboards specified. The program assumes there is one baseboard per room for sizing purposes. The total baseboard length determined for the room by the program can be divided into two or more shorter lengths during installation

NOTE: SINCE EACH ROOM CAN HAVE ONLY ONE BASEBOARD, THE NUMBER OF ROOMS IN THE ZONE IS ALWAYS THE SAME AS THE NUMBER OF BASEBOARDS IN THAT ZONE.

CIRCULATOR:
Use the up and down arrow keys scroll through the pull down list of available circulators. They are listed in alphabetical order by manufacturer. Click on the name of the circulator to be used in the circuit currently displayed. The circulator name will then appear in the frame marked “Circulator”. The program immediately recalculates and displays the circuit flow rate and required baseboard lengths assuming this circulator is used. The circuit flow rate with the currently selected circulator is displayed in the blue area above the circulator symbol.

The program also checks the flow velocity through the circuit based on the flow rate and pipe size. If the flow velocity exceeds 4 feet per second, a warning message is displayed. Although it may be acceptable to operate the circuit at a flow velocity over 4 feet per second, this can lead to flow noise, and hence the reason for the warning. The warning will disappear if the user changes one or more inputs that allow the flow velocity to drop to or below 4 feet per second.

SYSTEM FLUID:
This input allows the user to select the type of fluid used in the system. The currently selected fluid is always shown in the frame labeled "fluid type." Water, (the default fluid), as well as several concentrations of ethylene glycol and propylene glycol may be selected.

NOTE: WHEN DESIGNING A MULTIPLE ZONE SYSTEM BE SURE TO SELECT THE SAME TYPE OF FLUID FOR EACH ZONE CIRCUIT.

To change the fluid, click the down arrow to the right of the fluid name to display a list of available fluids. Click the name of the desired fluid. This name will be displayed as the current fluid type, and the fluid selection pull down list will close. As soon as the fluid type is changed, the program automatically recalculates the circuit flow rate, and the required baseboard lengths.

BASEBOARD DATA:
Each baseboard on the circuit has a button above its symbol labeled "Baseboard Data." Clicking this button opens a dialogue box for entering data specific to the room associated with that baseboard. This dialogue box can be dragged to a different location on the screen if desired.

ROOM NAME:
The program automatically assigns a default name to each room. These names will be "Room 1", Room 2, etc. The user can type in a new name of up to 16 characters if desired. This name will appear above the baseboard symbol when changes to the inputs in the dialogue box are accepted.

BASEBOARD TYPE:
The currently specified baseboard type is always shown in the dialogue box. Click the arrow to open a list of available baseboards. The baseboards are displayed in alphabetical order by manufacturer 's name. Use the scroll bar to move up and down through the list. Click on the name of the desired baseboard to select it.

The name is then display for baseboard type, and the baseboard selection pull down is closed.

The numbers to the right of the manufacturer and model description indicate the pipe size of that baseboard, and its IBR-rated heat output in Btu/hr/ft. if operated at 200 ºF and 1 gpm. The second number is only a reference value, and doesn't imply that any baseboard is currently operating at these conditions.

The IBR-rated heat output at 200 ºF and 1 gpm flow contains a 15% heating effect factor as allowed by the IBR rating standard. The program is set to remove this factor by default before sizing the baseboards. If the user wishes to include this factor, they can change the default to "Use IBR Heating Effect Factor" under the Settings pull down menu at the top of the screen.

NOTE: THE PROGRAM ASSUMES THE PIPE SIZE OF THE BASEBOARD ALWAYS MATCHES THE PIPE SIZE SPECIFIED UNDER PIPING DATA. IN THE EVENT OF A DIFFERENCE IN PIPE SIZES, THE FLOW CHARACTERISTICS OF THE CIRCUIT WILL BE COMPUTED BASED ON THE PIPE TYPE / SIZE SELECTED USING THE PIPING DATA BUTTON, NOT THE PIPE SIZE OF THE BASEBOARD.

The length of each baseboard is automatically calculated based on the load assigned to the room, the output characteristics of the selected baseboard, the circuit flow rate, and the fluid temperature at the location of the baseboard in the circuit.

DESIGN LOAD:
The user needs to enter the design heat loss of each room. This is done in the Baseboard Data dialogue box. The program assumes a default room heat loss of 5000 Btu/hr. To enter a different value, double click or drag over the number, and type in the heat loss. The value entered must be between 100 and 200,000 Btu/hr. Be sure this heat loss is calculated based on the desired room temperature at design load conditions, which is entered at the bottom of the dialogue box.

NOTE: IN A SERIES BASEBOARD CIRCUIT, THE PLACEMENT OF THE ROOM LOADS ALONG THE CIRCUIT SIGNIFICANTLY EFFECTS THE REQUIRED LENGTH OF THE BASEBOARD. BE SURE TO ENTER ROOM LOADS IN THE SAME SEQUENCE AS THE BASEBOARDS APPEAR ALONG THE CIRCUIT.

ROOM AIR TEMPERATURE:
This is the desired air temperature in each room. The default is 70 ºF. To change the value double click on or drag over the number and type in a new value. This value must be between 45 and 90 ºF.

Press the "Accept" button at the bottom of this dialogue box to allow the program to recalculate with the new selections and numbers. Press the "Cancel" button to ignore the changes and close the dialogue box.

PIPING DATA:
Clicking this button opens a dialogue box where the user can specify the piping, fittings, and valves present in the circuit.

The upper button labeled "Detail Method" is the default. This allows the user to select a pipe type / size, and enter its length, as well as specify the fittings and valves in the circuit. The lower button is labeled "IBR Approximate Method." Clicking this eliminates the need to enter fittings or valves. Instead, the program uses a relationship established by the IBR (Hydronics Institute) to estimate the total equivalent length of the circuit based on the length of the piping.

NOTE: THE PIPE SIZE SELECTED SHOULD BE THE SAME AS THAT OF THE SELECTED BASEBOARDS.

NOTE: THE PROGRAM ALWAYS BASES THE FLUID FLOW RATE CALCULATIONS ON THE PIPE SIZE SELECTED FROM THIS LIST, AND NOT THE PIPE SIZE OF THE SELECTED BASEBOARD.

NOTE: THE LENGTH OF PIPING ENTERED IS ASSUMED TO INCLUDE ALL THE BASEBOARDS IN THE CIRCUIT.

The user should enter the number of fittings and valves in the circuit on the list provided. When the piping, fittings, and valves have all been specified, click the "Accept" button to enter these values in the calculations. Click the "Cancel" button to return the piping inputs to their default values.

RESULTS:

The program recalculates and displays all output information whenever a change is made to the inputs. All calculated performance information in the Baseboard Calculator is displayed in red text.

FOR MULTI-ZONE SYSTEMS:
If the system has more than one zone, use the Displayed Zone field at the top of the screen to select the zone displayed.

FLOW RATE:
The flow rate through the specified circuit is displayed in the blue area above the circulator symbol.

TEMPERATURES:
The fluid temperature at each location in the circuit is displayed in the blue area above the thermometer symbols.

BASEBOARD LENGTHS:
The required length of each baseboard in the circuit is displayed in the blue area under each baseboard symbol. This length accounts for the water temperature at the baseboard's position in the system, as well as the flow rate, type of baseboard specified, and the room's heating load.

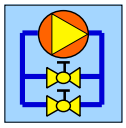
NOTE: THE BASEBOARD LENGTH CALCULATED IS ALWAYS ROUNDED UP TO NEXT WHOLE FOOT LENGTH WHEN DISPLAYED.

TOTAL SYSTEM LOAD:
The total load of ALL rooms in ALL zones is displayed in the blue area within the boiler symbol at the lower left corner of the screen. This number updates whenever changes that effect heating load are made to any room in any zone.

WARNING MESSAGES:
The program is designed to detect several conditions that may cause problems. These include excessive flow velocity, and low return water temperature to the boiler. When these conditions are detected, the program displays a warning message in an orange box indicating the problem, and suggesting ways to correct it.

PRINT SCREEN:

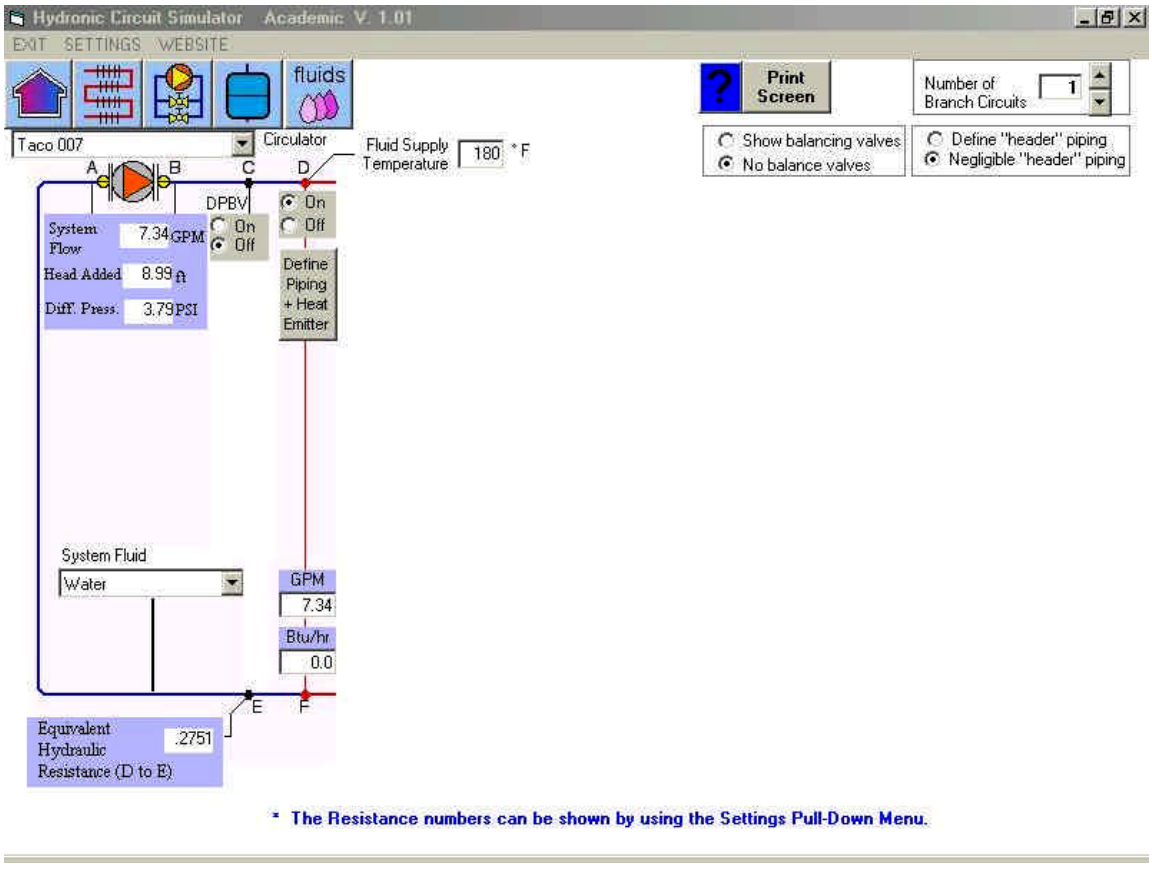
Pressing the “Print screen” key at the top of the screen will send the current screen image to the printer. Be sure the printer is on and connected before using this function.



HYDRONIC CIRCUIT SIMULATOR

GENERAL:

The HYDRONIC CIRCUIT SIMULATOR module allows the user to simulate the fluid flow is several types of hydronic circuits. The user configures the circuit by selecting the number of branches (1, 2, or 3), and then defining the piping components in each branch, as well as those in the "common piping." A variety of piping materials, sizes, and fittings can be selected from the various pull downs. The user can also specify the circulator and fluid type from pull down menus. The module also bases the fluid property values used in calculations on the user-specified average circuit temperature.



INPUTS:

NUMBER OF BRANCH CIRCUITS:
When the program first launches it shows one vertical "branch" (shown in red) as well as the common piping (shown in blue). In this configuration, the module can be used to simulate flow a series piping circuit.

NOTE: WHEN THE PROGRAM FIRST LAUNCHES, ALL PIPING IN THE CIRCUIT IS ASSUMED TO BE THAT SPECIFIED UNDER THE "ENTER PIPING + HEAT EMITTER" BUTTON. NO ADDITIONAL PIPING OR FITTING ARE ASSUMED IN THE COMMON PIPING.

To model circuits with more than one branch, enter 2 or 3 for the number of branch circuits. The academic version of the program is limited to a maximum of 3 branch circuits. The circuit drawing will automatically change to show the specified number of branches. As a default, each branch is assumed to contain 100 feet of 3/4" copper tubing.

HEADER PIPING:
When the program first launches the default configuration assumes negligible piping between the connecting points of the branch circuits. This would be representative of a radiant heating manifold, or a boiler header with very closely spaced zone take-offs.

The user can also choose to define piping segments called "headers" between the connecting points of the parallel branches. This is useful to accurately model the flow in a 2-pipe direct return system. This is done by clicking the "define header piping" button at the top of the screen. When this button is pressed, additional input buttons appear at the bottom of the screen. Click on any of these buttons to open a dialogue box to define the length, type, and size of the header piping. The default for all such piping selections is 100 feet of 3/4" copper tubing.

NOTE: THE HEADER PIPING TYPE, SIZE, AND LENGTH, AS WELL AS THE SPECIFIED FITTINGS ARE ASSUMED TO BE EQUALLY DIVIDED BETWEEN THE UPPER AND LOWER HEADER SEGMENTS BETWEEN ANY TWO ADJACENT BRANCHES.

For example, if the upper header segment is 50 feet of 1" tubing, and the lower header is also 50 feet of 1" tubing, the correct entry in the "define piping"

dialogue box is 100 feet of 1" tubing. The pipe size and material of the upper and lower header segments between any adjacent branches must always the same.

BALANCING VALVES:
The user can select to include or not include balancing valves in each branch circuit. When balancing valves are selected, the circuit drawing changes to show them in each branch, along with a slider box that can be used to change the flow resistance of each valve. Also shown will be an output frame on each branch that displays the Cv value corresponding to the current setting of the balancing valve.

CIRCULATOR SELECTION:
The currently selected circulator is displayed in the box at the upper left corner of the screen, (above the circulator symbol). The user can click the down arrow at the right side of the box to open a list of over 100 available circulators. Once the list is open, use the scroll bar at the right to move through the list of available circulators. The circulators are listed in alphabetical order by manufacturer. Clicking on a given model selects it, and closes the selection list. The circulator selection can be changed at any time. As soon as the circulator selection is changed, the program recalculates and displays the flows in all parts of the system. The flow rate through the circulator, as well as the head added and pressure gain across the circulator is displayed in the area directly below the circulator symbol.

BRANCH ON / OFF TOGGLE:
At the top of each branch is an on / off toggle switch. It represents the status of a zone valve in the branch. If the toggle is set to "on," flow is allowed through the branch. If the toggle is set to "off," no flow is allowed in that branch.
The toggle allows the user to simulate the effect of turning various parallel branches on and off, while observing the change in flow rate and head in other portions of the system. The default for all toggles is on.

NOTE: AN "ON" TOGGLE SETTING DOES NOT ACCOUNT FOR THE HYDRAULIC RESISTANCE OF A ZONE VALVE IN THE BRANCH. SUCH RESISTANCE MUST BE ACCOUNTED FOR SEPARATELY WHEN DEFINING THE BRANCH PIPING.

DEFINE PIPING + HEAT EMITTER:
This button appears on each parallel branch. Clicking it opens a dialogue box in which the user can define the piping components in that branch, as well as a baseboard element within the branch.

The dialogue box allows the user to select the method by which the branch piping is defined.

The default setting is to "Specify tubing and fittings." In this mode, the user specifies the type, size, and length of tubing, as well as the number and type of fittings in the branch. The length of tubing specified must be between 1 and 1000 feet.

If the user selects "Use hydraulic resistance as input", the dialogue box changes to allow the user to input a single number to represent the total hydraulic resistance of the branch. Methods given in chapter 6 of Modern Hydronic Heating can be used to determine this resistance.

SPECIFY HEAT EMITTERS:
The right side of the "Define Piping + Heat Emitters" dialogue box allows the user the option of including a fin-tube baseboard element in the branch circuit piping, or treating a portion of the branch circuit as a radiant panel circuit. If the default selection of "None" remains selected, no heat output is calculated.

If the button marked "Fin-tube Baseboard" is selected, the user is further prompted to enter a room air temperature as well as information on the baseboard element. The user should enter a length for the fin-tube element, and a number that gives the heat output of the baseboard at 200 ºF water temperature and 1 gpm flow rate. The program will adjust the heat output for the fluid temperature present at the inlet of the branch circuit. The heat output of each specified baseboard element will be given in the frame at the bottom of each branch circuit labeled "Btu/hr."

NOTE: THE PROGRAM DOES NOT ADD PIPE TO THE BRANCH CIRCUIT TO ACCOUNT FOR THE PRESENCE OF A FIN-TUBE ELEMENT. THE USER MUST ENTER ANY ADDITIONAL PIPING WHEN DEFINING THE PIPING IN THE BRANCH.

If the button marked "Radiant Floor Circuit" is selected, the user is further prompted to enter a room air temperature as well as information on the radiant circuit.

The user must select the type of floor construction from the pull down menu. Selections are available for slab-on-grade, thin-slab, as well as tube & plate systems. Different tube spacing are available for each type of construction.

The use must also enter an R-value for the finish floor system. This value must be between 0 and 2.5 (between 0 and 2.0 is recommended for conservative design). The R-value of some common finish floor systems can be referenced by clicking on the window for finish floor resistance.

NOTE: IN THE CASE OF BELOW FLOOR TUBE & PLATE SYSTEMS, THE THERMAL RESISTANCE OF 3/4" PLYWOOD SUBFLOORING IS ALREADY INCLUDED IN THE PERFORMANCE MODEL, AND SHOULD NOT BE CONSIDERED PART OF THE FINISH FLOOR SYSTEM.

NOTE: IN THE CASE OF ABOVE FLOOR TUBE & PLATE SYSTEMS, THE R-VALUE OF ANY COVER SHEET USED OVER THE PLATE SHOULD BE CONSIDERED PART OF THE FINISH FLOOR RESISTANCE.

The user can also specify the percentage of the branch circuit tubing length that is embedded in the floor panel. This allows the heat output to be calculated only for that portion of the circuit length.

NOTE: HEAT OUTPUT IS CALCULATED ONLY FOR THE PERCENTAGE OF THE BRANCH TUBING LENGTH THAT IS EMBEDDED IN THE FLOOR PANEL.

For example, if 90% is specified for this input, 90% of the tubing length specified for that branch is assumed to be in a floor panel having the currently specified construction and finish floor system. No heat output is calculated for the remaining 10% of the circuit. The entire equivalent length of the branch circuit is used for the flow calculation.

Once the appropriate tubing and fittings (or hydraulic resistance), as well as any heat emitter element present has been entered, click the "Accept" button to pass the information to the calculations and close the dialogue box. Pressing "Cancel" leaves the inputs the same as when the dialogue box was opened.

DEFINE COMMON PIPING:

To the left of point F on the system piping diagram is an input button labeled "define common piping." Pressing this button opens a dialogue box similar to that associated with the branch and header piping. The user can define the piping size, length, and fittings present in the "common" portion of the system piping between points C and E (e.g. the piping shown in dark blue). The user can also elect to enter a total hydraulic resistance to represent this portion of the system piping.

SYSTEM FLUID:
This input allows the user to select the type of fluid used in the system. The currently selected fluid is always shown in the frame labeled "fluid selection." Water, (the default fluid), as well as several concentrations of ethylene glycol and propylene glycol may be selected.

To change the fluid, click the down arrow to the right of the fluid name to display a list of available fluids. Use the scroll bar to move through the listing of available fluids. Click the name of the desired fluid. This name will be displayed as the current fluid type, and the fluid selection pull down list will close. As soon as the fluid type is changed, the module automatically recalculates and displays the flows rates in all parts of the system based on the properties of the selected fluid at the average system temperature.

FLUID SUPPLY TEMPERATURE:
The user enters the fluid temperature supplied to the heat emitters in the active branch circuit. Fluid properties such as density, specific heat, and viscosity are calculated at 10 ºF less than this temperature. The default value for the average fluid temperature is 180 ºF. The range of this input is 50 to 250 ºF.

DIFFERENTIAL PRESSURE BYPASS VALVE:
Directly below point C in the upper left side of the piping diagram is an on/off toggle labeled DPBV. This toggle determines if a differential pressure bypass valve (DPBV) is present in the system between points C and F in the piping diagram. When set to "Off", (the default setting), no DPBV is present.

If the toggle is set to "On," the circuit drawing changes to show the differential pressure bypass valve. Also displayed is a pull down listing of several commercially available DPBVs. The currently selected DPBV is shown in the box. Click on the down arrow at the right side of the box to open a listing of several commercially available DPBVs. Use the scroll bar to move through the listing. The valves are arranged in alphabetical order by manufacturer. Clicking a specific valve selects it and closes the pull down. The user also needs to set the "threshold pressure" of the DPBV. This value determines the pressure at which the DPBV first begins to open to allow bypass flow. It must be set between 1.42 and 8.52 psi.

BALANCING VALVES (Slider control):
If the "show balancing valves" setting is selected, a valve symbol will show near the middle of each branch. To the right of each balancing valve is a "slider" control

that can be used to change the hydraulic resistance of the balancing valve from zero to 10.0. The default setting of all sliders is with the bar at the top representing zero hydraulic resistance.

To increase the hydraulic resistance of the balancing valve, place the mouse arrow over the bar in the slider column and drag it downward. The bar can also be moved by holding the left mouse button down while the arrow is over the up or down arrows at the top and bottom of the slider control. Think of this action as equivalent to lower the stem of a balancing valve.

The Cv value corresponding to the current hydraulic resistance of the valve is updated as the bar is moved. The flow rates and heat outputs (if applicable) in all branch circuits are also updated as the bar is moved.

OUTPUTS:

All output values are recalculated and displayed whenever a change is made to any input. All outputs are displayed in light blue backgrounds.

SYSTEM FLOW RATE, HEAD ADDED, DIFFERENTIAL PRESSURE
The system flow rate, head added, and gain in differential pressure across the circulator (between points A and B is the system diagram) are always displayed directly below the circulator.

BRANCH FLOW RATE:
The flow rate through each active branch (in gallons per minute) is always displayed under the title “GPM” near the bottom of the branch path.

Cv OF BALANCE VALVES:
If balancing valves are present, the Cv value of each balancing valve that corresponds to its currently set hydraulic resistance is shown directly below the Cv label on the branch piping.

EQUIVALENT HYDRAULIC RESISTANCE:
The equivalent hydraulic resistance of the currently specified piping network TO THE RIGHT of point D and E in the displayed circuit diagram is always displayed in the blue output field near the lower left corner of the screen. NOTE: THIS VALUE DOES NOT INCLUDE THE RESISTANCE OF THE COMMON PIPING BETWEEN POINTS C AND F.

HYDRAULIC RESISTANCES:

A note at the bottom of the screen indicates that the hydraulic resistance values of the branches, main piping, and DPBV branch can be displayed by using the SETTINGS menu item at the upper left corner of the screen. If the program is set to display these hydraulic resistances, they will appear as blue numbers.

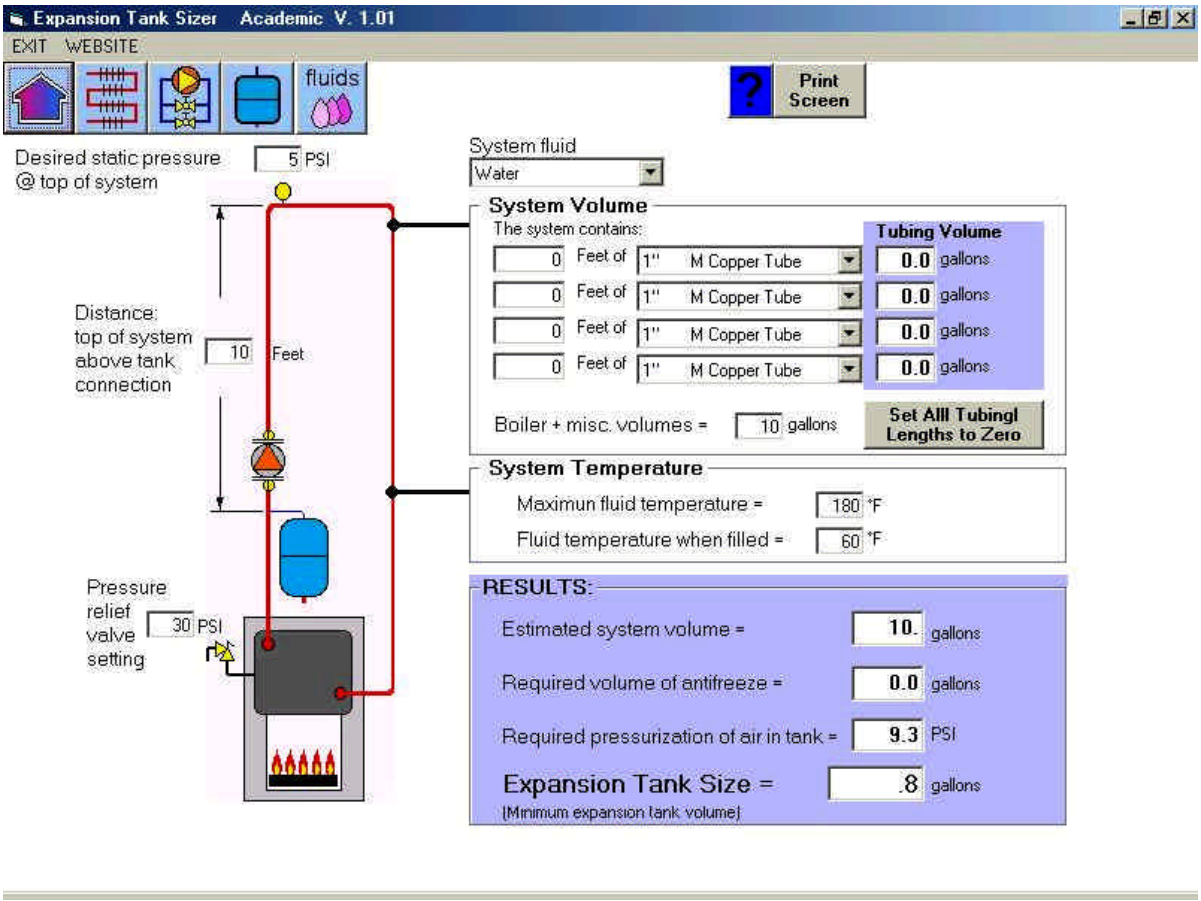
PRINT SCREEN:

Pressing the "Print screen" key at the top of the screen sends the current screen image to the printer. Be sure the printer is on and connected before using this function.

EXPANSION TANK SIZER

GENERAL:

The EXPANSION TANK SIZER module determines the minimum volume of a diaphragm-type expansion tank required for a user-specified closed-loop hydronic heating system. It also calculates useful information such as the volume of antifreeze that may be required, as well as the volume of various types and sizes of tubing.



INPUTS:

DESIRED STATIC PRESSURE AT TOP OF SYSTEM:
Enter a number between 0 and 10 psi for the desired static fluid pressure at the top of the system. A slight positive pressure ensures that air vents will be able to operate.

DISTANCE: TOP OF SYSTEM ABOVE TANK CONNECTION:
Enter a distance between 0 and 100 feet. This distance determines the static pressure exerted on the expansion tank by the fluid in the system. This pressure is shown as an output called Required pressurization of air in tank, in the blue results area at the bottom of the screen.

The installer should adjust the air pressure in the expansion tank to this value before filling the system will fluid. This ensures that the diaphragm is fully expanded against the shell of the tank before the fluid expands due to heating.

PRESSURE RELIEF VALVE SETTING:
Enter a value between 30 and 50 psi. This is the rated opening pressure of the relief valve. The program sizes the tank so that system pressure does not exceed this pressure minus 5 psi. This 5-psi margin prevents the relief valve from leaking at pressures just below its rated operating pressure. It also provides a safety factor considering that the pressure relief valve is often 2 to 4 feet below the inlet connection of the expansion tank.

NOTE: THE PROGRAM AUTOMATICALLY DETECTS WHEN THE STATIC PRESSURE IS HIGHER THAN THE RELIEF VALVE SETTING AND DISPLAYS A WARNING MESSAGE. TO CORRECT THIS SITUATION, REDUCE THE STATIC PRESSURE OR INCREASE THE PRESSURE RELIEF VALVE (IF ALLOWED BY CODE AND THE HEAT SOURCE USED).

SYSTEM FLUID:
Use the pull down menu to select the fluid in the system. Water, as well as several concentrations of propylene glycol and ethylene glycol are available for selection. All percentage concentrations are based on volume. The program sizes the expansion tank based on the expansion characteristics of the selected fluid.

SYSTEM VOLUME:
This area of the screen allows the user to enter lengths of up to four different types/sizes of tubing used in the system.

Use the pull down lists to select each type/size of tubing. The same selections of copper, PEX, and PEX-AL-PEX tubing are listed in each pull down. Use the scroll bar if necessary to view all the tubing selections available.

Enter the estimated length for each selected type/size of tubing. The output boxes in the blue area to the right of each tube selection show the fluid volume in the specified length of that tubing (in gallons). Note: If less than four types/sizes of pipe are used in the system, the user should leave the length of any unused tube selection field(s) set at the default value of zero.

BOILER + MISC. VOLUMES:
In addition to tubing, the system will contain fluid in the boiler (or other heat source), as well as components such as a buffer tank or heat exchanger. The user should enter the total volume of such components in the input labeled Boiler + Misc. Volumes.

The total volume of the specified tubing plus the boiler and misc. components is displayed in the output labeled "Estimated System Volume."

NOTE: THE USER CAN USE ANY ONE OF THE TUBING SELECTION LISTS IN THE SYSTEM VOLUME INPUTS TO QUICKLY CALCULATE THE VOLUME OF A GIVEN LENGTH OF TUBING. THE RESULTS ARE INSTANTLY UPDATED WHENEVER THE TUBING SELECTION IS CHANGED, OR A NEW NUMBER IS ENTERED FOR THE LENGTH OF TUBING.

MAXIMUM FLUID TEMPERATURE:
Enter the highest temperature the system fluid will achieve as the system operates. This number must be between 100 and 250 ºF.

Expansion tank sizing is somewhat conservative in that it assumes the entire system volume will achieve this temperature simultaneously. This is seldom the case since some fluid will be at a reduced temperature after releasing heat at the heat emitters.

FLUID TEMPERATURE WHEN FILLED:
Enter the temperature of the fluid used to fill and initially pressurize the system. A common value for cold fluid is 60 ºF. The value entered must be between 40 and 90 ºF.

RESULTS:

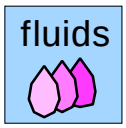
ESTIMATED SYSTEM VOLUME:
The total fluid volume of the system (not including the expansion tank) is displayed. This volume is based on the input information in the system volume field.

REQUIRED VOLUME OF ANTIFREEZE:
If an antifreeze solution was selected for the system fluid, the number of gallons of 100% antifreeze is displayed in this output.

REQUIRED PRESSURIZATION OF AIR IN TANK:
This output displays the pressure required on the air side of the diaphragm before the system is filled with fluid. Proper pressurization ensures the diaphragm is fully expanded against the steel tank shell after the system is filled, but before the fluid expands due to heating.

EXPANSION TANK SIZE (minimum required volume):
The volume of the smallest possible diaphragm expansion tank required by the system is displayed. Keep in mind that larger expansion tanks are possible, and will slightly reduce pressure fluctuations in the system. They do however add to cost.

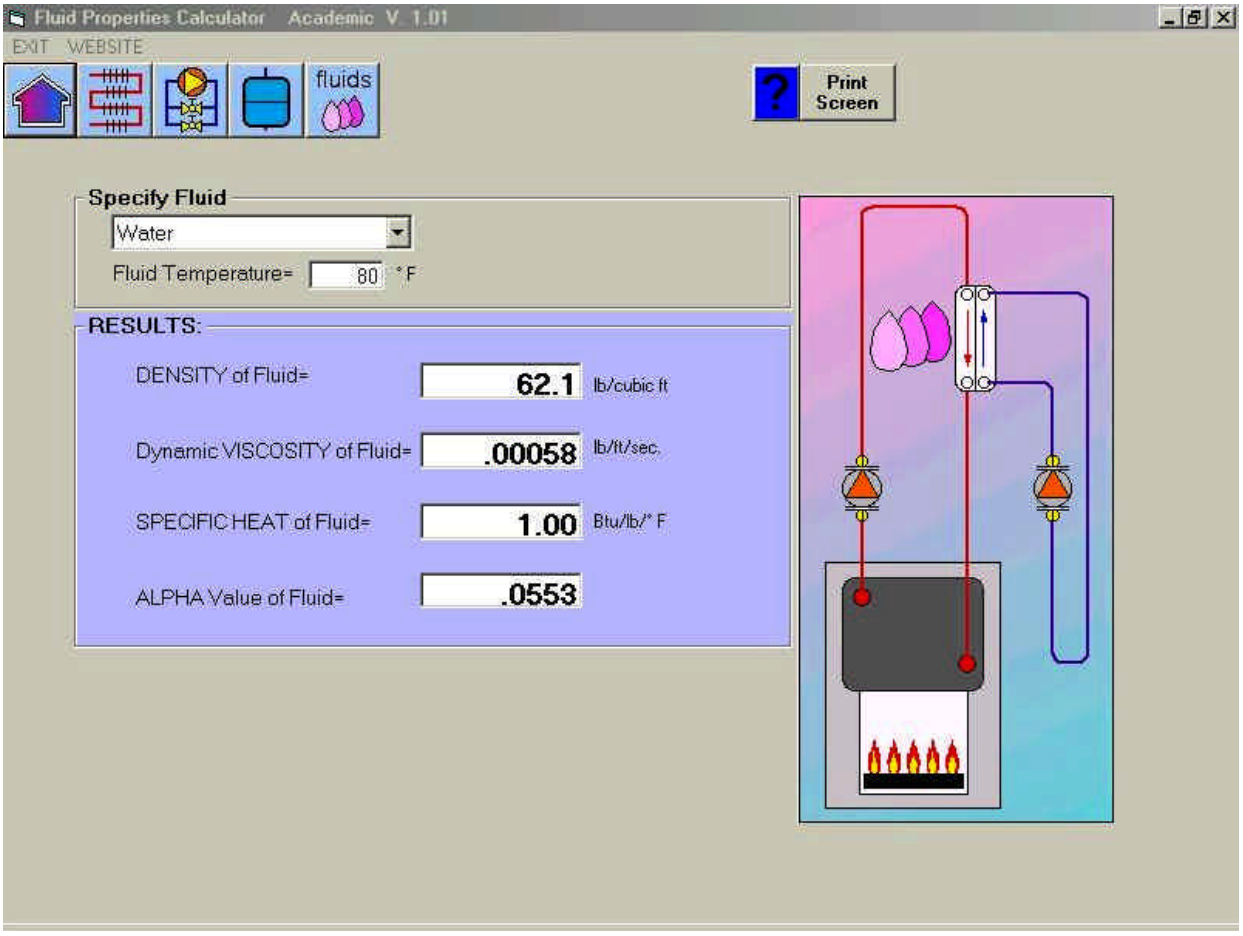
PRINT SCREEN:
Pressing the “Print screen” key at the top of the screen sends the current screen image to the printer. Be sure the printer is on and connected before using this function.



FLUID PROPERTIES CALCULATOR

GENERAL:

The FLUID PROPERTIES CALCULATOR module calculates several properties for fluids commonly used in hydronic heating systems. Those properties are density, viscosity, specific heat, and the "alpha-value' which is used to determine hydraulic resistance.



INPUTS:

SPECIFY FLUID:
Use the pull down list to select the fluid for which the properties are to be determined. Water, as well as several concentrations of ethylene glycol and propylene glycol are available. NOTE: All glycol percentages are volume percentages.

FLUID TEMPERATURE:
Enter the temperature at which the fluid properties are to be determined. The value entered must be between 32 ºF and 250 ºF.

When evaluating the effect of the fluid on the performance of a hydronic system, it is customary to use the AVERAGE fluid temperature while the system operates at design load conditions. For example, if the fluid leaves the heat source at 180 ºF and returns to the heat source at 150 ºF, use the average fluid temperature of 165 ºF when evaluating the effect of the fluid on system performance.

RESULTS:

DENSITY:
The weight density of the selected fluid at the specified temperature is given in pounds per cubic foot.

DYNAMIC VISCOSITY:
The dynamic viscosity of the selected fluid at the specified temperature is given in pounds per foot per second. Dynamic viscosity is the specific type of viscosity required in any formulas or other computations associated with the text Modern Hydronic Heating.

SPECIFIC HEAT:
The specific heat of the selected fluid at the specified temperature is given in Btu per pound per ºF.

ALPHA VALUE:
The alpha value of the selected fluid at the specified temperature is given. The alpha value is called the fluid properties factor in chapter 6 and later chapters of Modern Hydronic Heating. It is a parameter involving both density and dynamic

viscosity, which determines the effect of the fluid on the head loss of a piping circuit.

PRINT SCREEN:
Pressing the “Print screen” key at the top of the screen sends the current screen image to the printer. Be sure the printer is on and connected before using this function.

